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CATCH AND EFFORT STATISTICS FOR THE SOCKEYE SALMON SPORT FISHERY IN THE RUSSIAN RIVER WITH ESTIMATES OF ESCAPEMENT, 1989[1]

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ABSTRACT

A creel survey of the Russian River recreational fishery was conducted in 1989 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 78,702 angler-hours to harvest 11,285 sockeye salmon from the early run (June 10-June 30) and 154,513 angler-hours to harvest 55,210 sockeye salmon from the late run (July 16-August 20). The early run fishery was closed by emergency order from July 1 through July 15 to ensure the escapement goal of 20,000 would be achieved, but escapement totaled only 15,338 fish by the end of the early run migration on July 20. A total of 153,656 sockeye salmon were counted through the weir at the outlet of Lower Russian Lake bound for spawning areas upstream of the weir: 15,338 and 138,318 from the early and late runs, respectively. Both the early and late run escapements were sampled at the weir and were comprised of five age groups: 2.3, 1.3, 2.2, 1.2, and 2.1. Early run fish sampled at the weir were predominantly age 2.3 (67.3 percent) while late run fish sampled at the weir were comprised of two major age classes: 2.2 (62.7 percent) and 2.1 (34.1 percent). A stream survey indicated that a minimum of 28,480 sockeye salmon spawned in the river reach downstream from the weir and between the Russian River falls and the confluence of the Russian and Kenai Rivers. Carcass sampling indicated that these fish were predominantly age 1.3 (74.8 percent).

KEY WORDS: Russian River, sockeye salmon, *Oncorhynchus nerka*, creel survey, harvest, effort, weir, escapement.

INTRODUCTION

The Russian River is a clearwater stream located in the central Kenai Peninsula near Cooper Landing, Alaska. The drainage includes two large clearwater lakes, Upper and Lower Russian Lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak Lakes (Figure 1). The largest recreational fishery for sockeye salmon *Oncorhynchus nerka* in Alaska occurs in the Russian River and at its confluence with the Kenai River. Annual effort by anglers in this fishery has exceeded 450,000 angler-hours and annual harvests have exceeded 190,000 fish. Prior information pertaining to this fishery is presented by Lawler (1963, 1964), Engel (1965-1972), Nelson (1973-1985), Nelson et al. (1986), McBride and Athons (1987), and Hammarstrom and Athons (1988, 1989).

Unknown numbers of sockeye salmon of Russian River origin are also harvested by the sport fishery in the mainstem of the Kenai River, the personal-use dip net fishery in the Kenai River, and the commercial fishery in Upper Cook Inlet. Estimates of the total harvest of sockeye salmon by sport fisheries in the mainstem of the Kenai River have been reported annually since 1977 by Mills (1979-1989). The personal-use dip net harvest has been estimated in the Statewide Harvest Survey since 1983 (Mills 1984-1989). The commercial catch and total returns of sockeye salmon to the Kenai River have been reported by Cross et al. (1983, 1985, 1986).

Sockeye salmon return to the Russian River in two temporal components, termed early and late runs. The early run typically arrives at the Russian/Kenai River confluence in early June. By mid July, these fish have migrated through the Russian River and into Upper Russian Lake. The early run spawns almost exclusively in Upper Russian Creek (Nelson 1973, 1974) and is comprised primarily of 3-ocean fish (Nelson 1973-1985). Early run fish typically remain in the confluence area for up to 2 weeks before continuing their migration. Late run sockeye salmon arrive at the confluence in mid to late July, move almost immediately into the Russian River, and are available to anglers through August. Late run fish are comprised of two segments: those spawning upstream of a weir located near the outlet of Lower Russian Lake and those spawning downstream of the weir. While most fish that pass through the weir spawn in Upper Russian Lake, others spawn in the tributaries to Upper Russian Lake and in the river section between the upper and lower lakes. Fish that spawn above the weir are primarily 2-ocean fish and are believed to rear in the two lakes. The other segment, which spawns in the Russian River downstream from the falls and are primarily 3-ocean fish, are more closely associated with the age structure of sockeye salmon spawning in the mainstem Kenai River (Cross et al. 1983, 1985, 1986). These fish are believed to spend their freshwater residency in Skilak Lake.

The Sport Fish Division of the Alaska Department of Fish and Game regulates the recreational fishery to ensure that a minimum number of spawning sockeye salmon for each run passes through a weir at the outlet of Lower Russian Lake. Current goals are 20,000 fish for the early run and 30,000 fish for the late run. These goals are based on evaluation of returns from past brood years. Despite an emergency closure of the early run fishery (July 1 through July 15), the early run goal was not achieved in 1989. On only one other

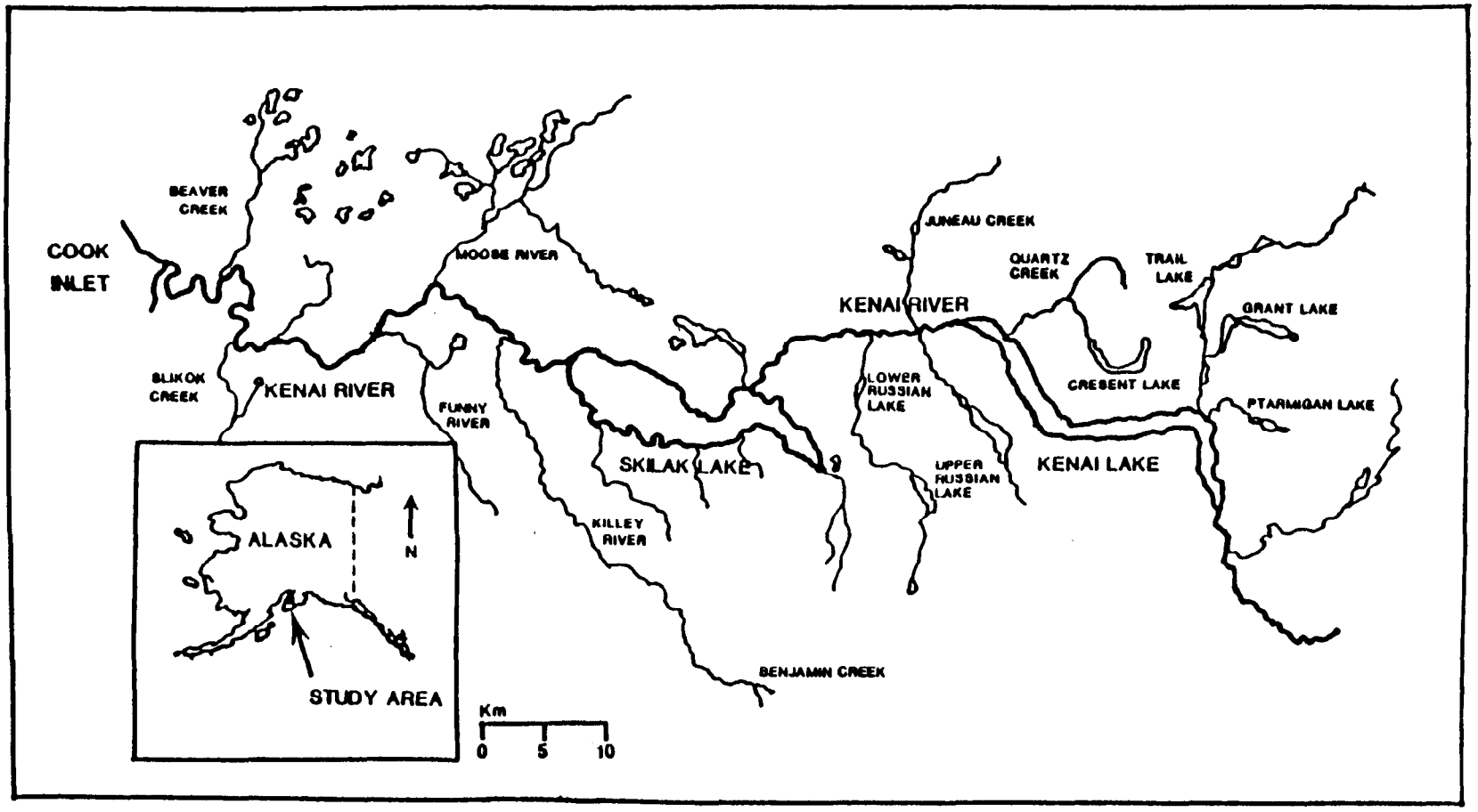

Figure 1. Map of the Kenai River drainage.

occasion (late run, 1977) has an escapement goal not been achieved since the goals were established (Nelson 1978).

From June 1 through August 20, the daily bag and possession limit for sockeye salmon taken from the Kenai/Russian River fly-fishing-only area (Figure 1) was three fish which were 406 mm (16 in) or more in length. Within this area, from a marker located 540 m (600 yd) downstream from the Russian River falls to a marker located on the Kenai River 1,620 m (1,800 yd) downstream of the confluence with the Russian River, only a single-hook, unbaited, unweighted fly with a point-to-shank measurement of 9.5 mm (3/8 in) or less constituted legal terminal tackle. Any weights attached to the line were required to be a minimum of 457 mm (18 in) above the hook.

Given that the recreational fishery for sockeye salmon in the Russian River is the largest in the state in terms of angler effort, there is a potential for overharvest. Precise and timely management decisions are required to ensure that adequate escapement is obtained. The data necessary for these decisions are provided by a creel survey and a counting weir. The creel survey provides data on angler effort and harvest while the weir operations provide daily escapement. Estimates of the total inriver return (harvest plus escapement) and the age, sex, and size compositions of the return provide information used to evaluate production and to estimate optimum spawning escapement levels.

The objectives of this report are to present, for 1989: (1) estimates of effort and harvest of sockeye salmon for the recreational fishery; and (2) estimates of the escapements of the early and late run return of sockeye salmon.

METHODS

Study Area

The recreational fishery occurs in two areas: (1) the confluence area, which extends from the upper limit marker of the sanctuary area[1] downstream approximately 1.6 km to a marker on the Kenai River identifying the downstream limit of the "fly-fishing-only" area; and (2) the river area, which extends from the upper limit of the sanctuary area upstream approximately 3.2 km on the Russian River to a marker identifying the upper limit of the "fly-fishing-only" area (Figure 2). Access to the two fishing areas is primarily through a U.S. Forest Service (USFS) campground located on the east side of the Russian River or through the parking area administered by the United States Fish and Wildlife Service (USFWS) located on the north bank of the Kenai River directly across from the Russian River terminus. Immediately adjacent to the USFWS parking area is a cable ferry which traverses the Kenai River. Most anglers fishing the confluence area use the ferry to reach the

[1] The sanctuary area begins in the Russian River, 137 m upstream of the confluence with the Kenai River and extends downstream in the Kenai River to the ferry cable (approximately 640 m).

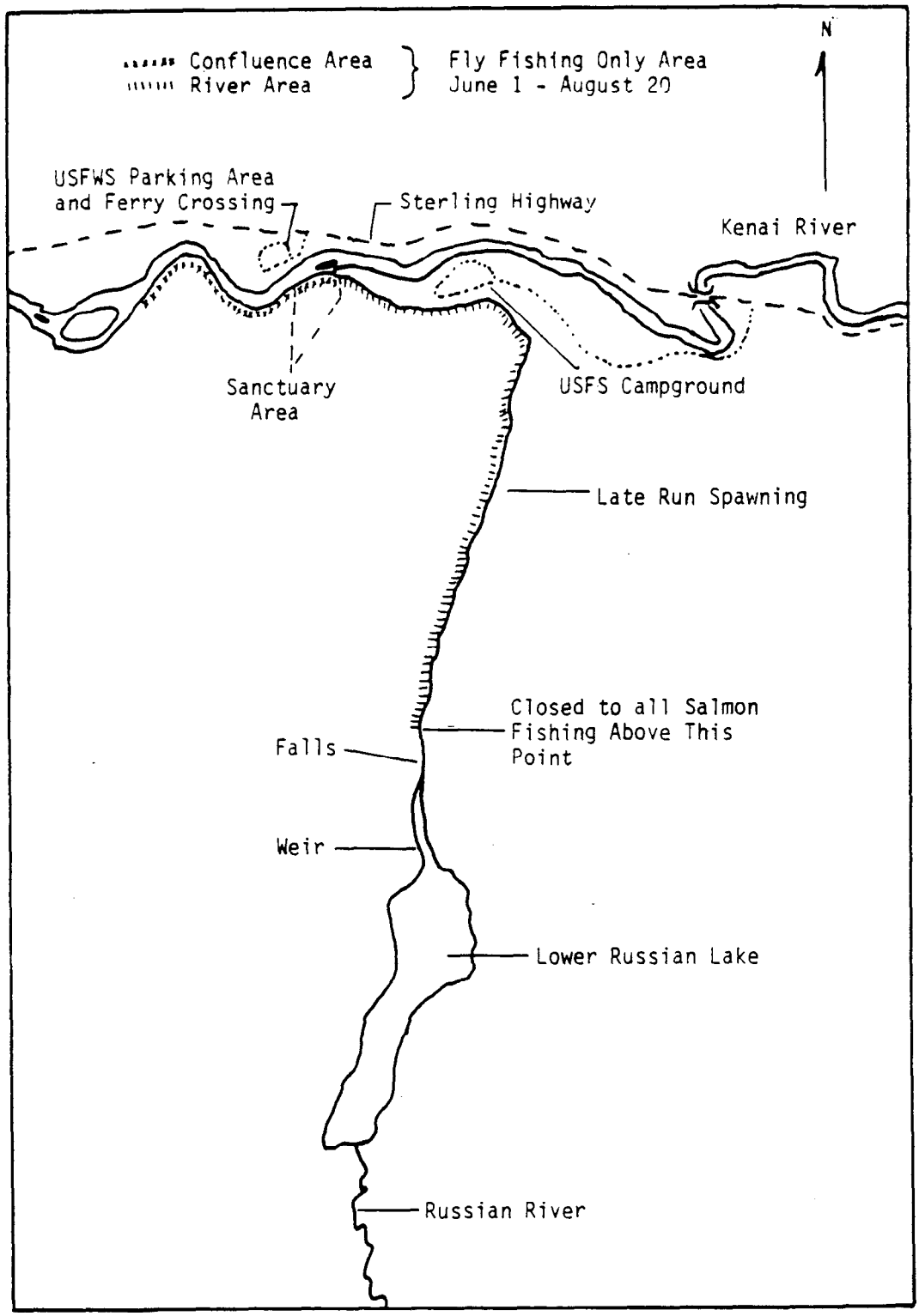

Figure 2. Map of the lower Russian River and the Kenai and Russian River confluence.

south bank of the Kenai River. Both the parking area and the ferry are operated privately under a concession administered by the USFWS.

A weir, constructed of metal and wood, is located just downstream from the outlet of Lower Russian Lake and approximately 360 m (400 yd) upstream from the Russian River falls. The weir provides a complete count of the early run spawning escapement and that portion of the late run that spawns upstream from the weir. Late run fish that spawn downstream from the Russian River falls are visually counted during stream surveys.

Study Design

Creel Surveys:

The fishery was divided into five components based on run timing and area of fishery:

1. Early run/confluence area (6/10-6/30);
2. Early run/river area, zero harvest rate (6/10-6/22);
3. Early run/river area, non-zero harvest rate (6/22-6/30);
4. Late run/confluence area (7/16-8/20); and,
5. Late run/river area (7/16-8/20).

Each component, with the exception of the two early run/river components, was stratified into weekdays and weekend/holidays, as historically, effort on weekdays has been less than on weekend days.

The early run river fishery was divided into two components due to the behavior of returning fish and the abbreviated early run fishing season that was closed by emergency order in an effort to achieve the minimum escapement goal. Harvest and effort estimates for the early run river fishery were made for two temporal components: 1) the zero harvest rate component, when the daily angler harvest rates were zero prior to the movement of early run fish into the river, and 2) the non-zero harvest rate component when fish were present in the river in catchable numbers. Dividing the early run river fishery into two components resulted in small sample sizes in each early run component. Separate effort estimates by period for weekdays and weekend/holidays were therefore precluded, because some periods were not sampled in this stratification scheme. Because it was not possible to stratify by period and day type (weekday or weekend/holiday), each of the temporal components was stratified by week. Weekdays and weekend/holidays were pooled within each week as there was no significant difference among weekday and weekend angler counts ($P>0.05$).

Differentiation between the two runs was based on subjective observations of harvest rates and external maturation characteristics of harvested sockeye salmon. Entry of late run fish into the fishery has historically been typified by a surge of ocean-bright fish numerically overwhelming the remaining, more sexually advanced early run fish. Immediately following the arrival of these ocean-bright fish there is usually a dramatic increase in the harvest rate in the confluence area.

A roving creel survey (Neuhold and Lu 1957), using a stratified random sampling design, was used to count anglers, conduct angler interviews, and sample the sport harvest. The fishing day during the early run was defined as 18 hours long from 0600-2400, and stratified into three periods: A from 0600-1159, B from 1200-1759, and C from 1800-2400. In previous years, effort during the period from 2400 to 0600 has been considered insignificant, however, observations during 1987 indicated that effort may be significant during the early run, especially when very large numbers of fish are present. In fact, during the return of 100,000 early run fish in 1988, effort expended during this time period accounted for 15% of the total early run effort in the river area and 9% in the confluence area (Hammarstrom and Athons 1989). However, from staff observations, the 1989 return of 26,600 early run fish resulted in little effort being expended during this time period. Effort during this period was considered insignificant in 1989 and angler counts were not made.

The fishing day during the late run was also defined as 18 hours long and stratified into the same periods used during the early run. Declining daylight during the late run appears to discourage anglers and casual observations by survey technicians have not indicated significant participation during hours of darkness; effort expended between the hours of 2400 to 0600 was considered insignificant.

Historically, the area receiving the most fishing effort changes during the season as the concentration of fish moves from the confluence area into the river area. To accommodate this trend, sampling effort was concentrated in the area receiving the most pressure as the season progressed.

At least two angler counts were scheduled during each period (A, B, and C) in the weekday and weekend/holiday components of each survey area. Two hours were allotted for counts in the river area (1 hour counting and 1 hour travel time to/from the physical limits of the area) and 1/2 hour for counts in the confluence. Sampling effort was distributed about equally among the three periods. Days to be sampled were randomly selected on a weekly basis. Sample periods for each area were then selected for each day. Count times were selected randomly within each selected period. Counts during adjacent periods in the same sample area were scheduled 6 hours apart to minimize the covariance among counts on the same day. All counts reflected fishing effort at the time of the count and were considered instantaneous (Neuhold and Lu 1957).

The time remaining in a selected sample period after a count was made was used to conduct interviews of anglers who had completed fishing (completed trip anglers) such that 7 hours of survey time were scheduled each day. Interviews were conducted at one of two places: (1) the access trails leading from the USFS campground to the Russian River, or (2) the ferry crossing adjacent to the USFWS parking area. The following information was recorded for each completed trip angler interviewed: (1) the number of hours fished; (2) location fished, river or confluence; and (3) the number of sockeye salmon retained.

The number of angler-hours of effort (E) during fishery component t was estimated as follows (Neuhold and Lu 1957):

$$\hat{E}_t = \sum_{j=1}^{3} H_{tj}\bar{x}_{tj}, \qquad [1]$$

where, for the two early run river components:

$\bar{x}_{tj}$ = the mean number of anglers per count during week j of fishery component t;

H_{tj} = the total number of hours of possible fishing time during week j of fishery component t; and,

where, for the other three components:

$\bar{x}_{tj}$ = the mean number of anglers per count during period j of fishery component t; and

H_{tj} = the total number of hours of possible fishing time during period j of fishery component t.

The variance of effort was estimated as follows (Scheaffer et al. 1979):

$$V(\hat{E}_t) = \sum_{j=1}^{3} H_{tj}^2 \, (s_{tj}^2/n_{tj}), \qquad [2]$$

where s_{tj}^2 is the sample variance of $\bar{x}_{tj}$, n_{tj} is the number of angler counts during week j of component t (for the two early run river components), and n_{tj} is the number of angler counts during period j of component t (for the other three components).

Mean effort and mean harvest of sockeye salmon per angler were estimated from the angler interview data for each of the components. Mean effort was estimated as:

$$\bar{f}_t = \left(\sum_{i=1}^{D} \sum_{k=1}^{m_i} f_{ik} \right) \Big/ \sum_{i=1}^{D} m_i, \qquad [3]$$

where:

f_{ik} = the effort (in hours) by angler k interviewed on day i,

m_i = the number of anglers interviewed on day i, and

D = the number of days the fishery was open during component t.

The variance of mean effort was estimated using a two-stage sample design with days representing the first-stage sample units and anglers the second-stage sample units (Von Geldern and Tomlinson 1973). On a given sample day, the number of second-stage units available was unknown. The variance of mean effort was estimated as follows (Sukhatme et al. 1984):

$$V(\bar{f}_t) = [1 - (d/D)]\, s_B^2/d + \left(\sum_{i=1}^{d} s_{Wi}^2/m_i\right)/dD, \qquad [4]$$

where:

d = the number of days sampled during component t;

s_{Wi}^2 = the sample variance of effort for anglers interviewed during day i; and,

s_B^2 = the between-day variance of angler effort.

The between-day variance, s_B^2, was estimated as follows:

$$s_B^2 = \left[\sum_{i=1}^{d} (\bar{f}_{ti} - \bar{f}_t)^2\right]/(d-1), \qquad [5]$$

where:

$\bar{f}_{ti}$ = the mean effort by anglers interviewed during day i of component t.

The sample variance of effort for anglers interviewed during day i, s^2_{wi}, was estimated as follows:

$$s^2_{Wi} = \left[\sum_{j=1}^{m_i} (f_{tij} - f_{ti})^2\right]/(m_i-1) \qquad [6]$$

where:

f_{tij} = effort expended by angler j during day i and component t.

Mean harvest and its variance were estimated identically to effort except the corresponding quantities for the harvest of sockeye salmon were substituted for all occurrences of effort (f).

Harvest rate of sockeye salmon (HPUE), defined as number of sockeye salmon harvested per hour, during component t was estimated by:

$$\hat{HPUE}_t = \bar{c}_t/\bar{f}_t, \quad [7]$$

where:

$\bar{c}_t$ = the mean harvest of sockeye salmon per angler during fishery component t.

The variance of $\hat{HPUE}_t$ is approximated by the variance for the quotient of the mean of two random variables (Jessen 1978), which is:

$$V(\bar{c}_t/\bar{f}_t) \approx (\bar{c}_t/\bar{f}_t)^2 (s_c^2/\bar{c}_t^2 + s_f^2/\bar{f}_t^2 - 2rs_c s_t/\bar{c}_t\bar{f}_t), \quad [8]$$

where:

s_c^2 = the two-stage variance estimate for $\bar{c}_t$;

s_f^2 = the two-stage variance estimate for $\bar{f}_t$; and,

r = the correlation coefficient between the f_{tj} and the c_{tj} in component t.

The harvest of sockeye salmon during each component of the Russian River fishery was estimated by:

$$\hat{H}_t = \hat{E}_t \hat{HPUE}_t. \quad [9]$$

The variance of $\hat{H}_t$ was estimated using Goodman's (1960) formula for the variance of the product of two independent random variables which is:

$$V(\hat{H}_t) = [\hat{E}_t^2 V(\hat{HPUE}_t)] + [\hat{HPUE}_t^2 V(\hat{E}_t)] - [V(\hat{E}_t) V(\hat{HPUE}_t)]. \quad [10]$$

Totals (for example, the early run total) for effort and harvest were estimated by summing the appropriate components. Estimates of effort and harvest for the components are considered independent estimates, therefore, the variance of the total was estimated by the sum of the appropriate variances.

The assumptions necessary for these analyses are:

1. Significant fishing effort occurs only between the hours defined for the angler-day.

2. Individual angler effort and angler harvest are normally distributed independent random variables.

3. Anglers are interviewed in proportion to their abundance (DiConstanzo 1956).

4. Interviewed anglers are representative of the total angler population.

5. Total effort and HPUE are independent, i.e., the number of anglers does not affect angler success.

Spawning Escapement:

The escapement of spawning sockeye salmon into the Russian River drainage (Figure 1) was counted at a weir on the outlet of Lower Russian Lake using methods similar to those described by Nelson (1976). The weir was constructed of steel and wood with pickets leading to a holding box through which fish were individually counted. During the period of overlap between the early and late runs (mid to late July), fish from each run were subjectively identified by degree of external maturation and counted separately. This procedure began July 16 when bright fish were present with mature fish and continued through July 20 when mature fish were no longer present.

Salmon spawning in the river reach between the Russian River falls and the confluence of the Russian and Kenai Rivers were visually enumerated on one occasion. Typically, at least two counts are made, but flood conditions and turbid water precluded the second count.

Biological Data:

Four groups of sockeye salmon were sampled for biological data: (1) early run fish at the weir, (2) late run fish at the weir, (3) late run fish spawning in the river reach between the falls and the confluence, and (4) late run fish harvested in the confluence area (which includes sockeye salmon from the mainstem Kenai River). Two temporal components of the early run escapement were sampled, one before the peak and one after the peak of the return. The late run fish passing through the weir were sampled over three temporal components. Fish spawning between the falls and the confluence were sampled by examining carcasses found on gravel bars and along the river bank. The late run harvest was sampled over two temporal components.

Scales were collected from the preferred area of each sampled fish and placed on adhesive-coated cards (Clutter and Whitesel 1956). The sex and length (measured from the mid-eye to the fork-of-tail in millimeters) of each sampled fish were also determined and recorded. Scale impressions were made in clear acetate and examined with a microfiche reader to determine age. The European method of age description was used to record ages: the numeral preceding the decimal represents the number of freshwater annuli and the numeral following the decimal represents the number of marine annuli. Total age from brood is therefore the sum of the two numbers plus one.

Age and sex composition were estimated for each group of sockeye salmon sampled. The proportion of fish of age group h in group i was estimated as:

$$\hat{P}_{hi} = n_{hi}/n_{Ti}. \qquad [11]$$

where:

n_{hi} = the number of legible scales read from sockeye salmon sampled from group i and interpreted as age h; and,

n_{Ti} = the total number of legible scales read from sockeye salmon sampled from group i.

The variance of $\hat{P}_{hi}$ was estimated as (Scheaffer et al. 1979):

$$V(\hat{P}_{hi}) = \hat{P}_{hi}(1-\hat{P}_{hi})/(n_{Ti}-1). \quad [12]$$

The numbers of sockeye salmon (N_{hi}) by age group h and sex i were estimated for the early run and late run escapements using the estimates of the age group proportions (P) as defined previously:

$$\hat{N}_{hi} = N_{Tj}\hat{P}_{hi}, \quad [13]$$

where:

N_{Tj} = the total number of sockeye salmon of run j counted at the weir or below the falls.

The variance of $\hat{N}_{hi}$ was estimated as:

$$V(\hat{N}_{hi}) = N_{Tj}^2 V(\hat{P}_{hi}). \quad [14]$$

The estimates of the early and late run sport harvests (H) were also apportioned by sex and age group:

$$\hat{N}_{hi} = \hat{H}_{Tj}\hat{P}_{hi}, \quad [15]$$

where:

$\hat{H}_{Tj}$ = the estimate of total harvest of sockeye salmon in run j.

The variance of $\hat{N}_{hi}$ was estimated using the formula for the product of two independent random variables (Goodman 1960):

$$V(\hat{N}_{hi}) = \hat{H}_{Tj}^2 V(\hat{P}_{hi}) + \hat{P}_{hi}^2 V(\hat{H}_{Tj}) - V(\hat{P}_{hi}) V(\hat{H}_{Tj}), \quad [16]$$

where:

$\hat{V}(H_{Tj})$ is the sum of the variances of the harvest estimate over fishery component in run j as defined previously.

The age composition of the early run escapement sample was used to apportion both the escapement and early run harvest. The samples from the late run harvest, the late run escapement through the weir, and the late run escapement between the falls and the confluence were used to estimate the sex-age compositions for their respective populations.

Mean length at age by sex and its variance were estimated using standard normal procedures.

RESULTS

Creel Statistics

Typically, temporal changes in angler effort are apparent during the season and appear to correspond to the presence of the two runs of sockeye salmon returning to the Russian River system (Nelson 1975-1985; McBride and Athons 1987; Hammarstrom and Athons 1988, 1989). In 1989, peak effort was expended in both the confluence area and the river area when fish were present in greatest abundance in those areas. The decline from peak effort expended during the early run at the confluence area coincided with the movement of available fish from the confluence area into the Russian River (Figures 3 and 4). A dramatic increase in harvest rates in the river area accompanied an increase in effort as anglers responded to fish movements.

During the late run, peak effort in the confluence area coincided with peak harvest rates. Effort in the river increased dramatically with an increase in harvest rates, but decreased prior to the close of the season on August 20 when harvest rates were still high (Figures 3 and 4).

Over half of the mean counts of anglers for weekdays was less than for weekends (Table 1). Early and late run effort was estimated as 78,702 and 154,513 angler-hours, respectively, for a total estimated effort of 233,215 angler-hours (Table 2). The confluence area received 67% of the early run effort and 70% of the late run effort (Figure 5). The zero harvest rate component of the early run river fishery accounted for 6,701 angler-hours or 9% of the total early run effort (Figure 5). Daily HPUE of sockeye salmon (Appendices A3 through A6) in each area was bimodal corresponding to the timing of early and late runs (Figure 4). There was no significant difference in HPUE ($P>0.05$) between weekend and weekday strata within a location and seasonal component (Figure 6 and Table 3).

The early and late run sockeye salmon harvests were estimated as 11,285 and 55,210 fish, respectively, for a total harvest estimate of 66,495 fish (Tables 4 and 5). The confluence area accounted for 61% of the early run harvest and 66% of the late run harvests (Figure 5).

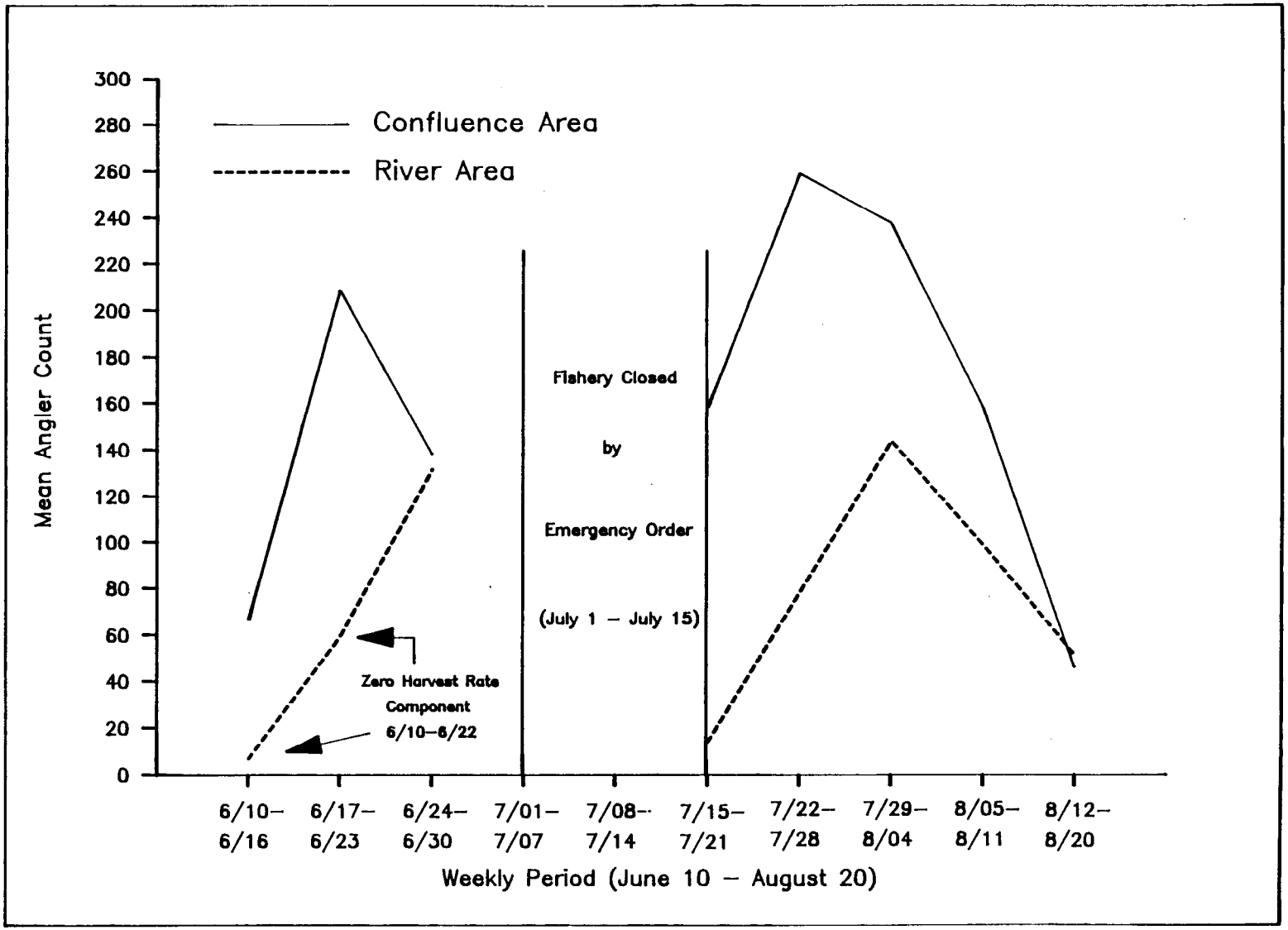

Figure 3. Mean angler count by week and area in the Russian River recreational sockeye salmon fishery, 1989.

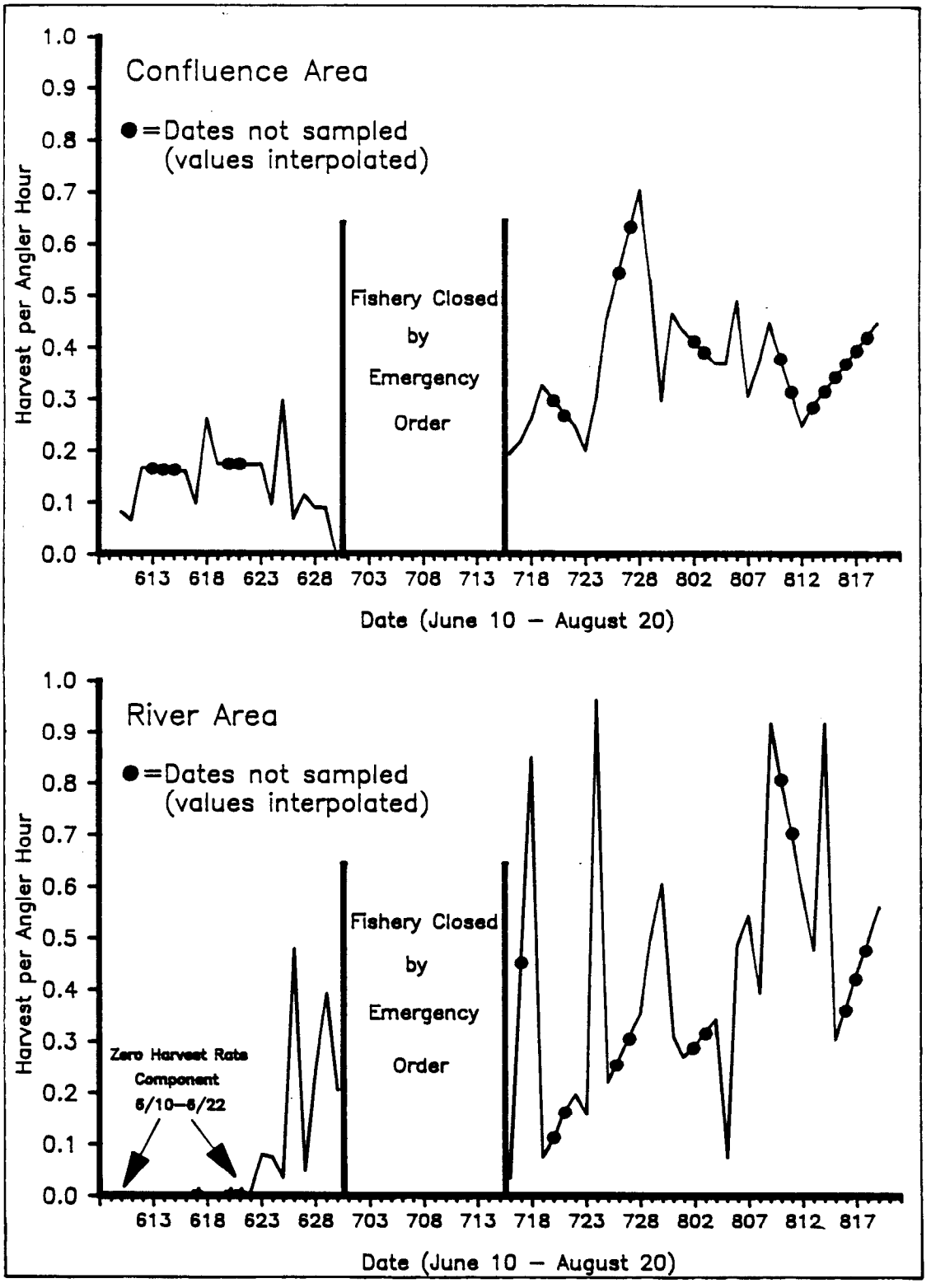

Figure 4. Mean harvest of sockeye salmon by date and area in the Russian River recreational fishery, 1989.

Table 1. Mean counts of anglers by period for each component of the Russian River creel survey, 1989.

	Period					
	Confluence			River		
	A	B	C	A	B	C
EARLY RUN						
Weekdays						
Number of counts	6	5	3	2	4	2
Mean Count	110	143	167	137	80	73
Standard Error	20	25	46	22	40	47
Weekends						
Number of counts	4	5	3	2	2	2
Mean Count	137	194	157	37	78	6
Standard Error	41	40	79	37	70	4
LATE RUN						
Weekdays						
Number of counts	10	8	10	5	8	6
Mean Count	113	141	160	61	76	58
Standard Error	32	32	23	19	16	18
Weekends						
Number of counts	5	7	6	3	6	3
Mean Count	207	280	204	141	91	32
Standard Error	66	60	54	56	26	8

Table 2. Estimated number of angler-hours of fishing effort during each component of the Russian River sockeye salmon fishery, 1989.

Component	Estimated Effort	Standard Error	95% Confidence Interval	Relative Precision
CONFLUENCE				
Early Run				
Weekdays	34,684	3,697	27,437 - 41,931	20.9%
Weekends	17,919	450	17,037 - 18,801	4.9%
Total	52,603	3,725	45,303 - 59,903	13.9%
Late Run				
Weekdays	62,093	7,537	47,320 - 76,886	23.8%
Weekends	45,601	6,874	32,127 - 59,075	29.5%
Total	107,694	10,201	87,700 - 127,688	18.6%
Total				
Weekdays	96,777	8,395	80,323 - 113,231	17.0%
Weekends	63,520	6,889	50,018 - 77,022	21.3%
Total	160,297	10,860	139,011 - 181,583	13.3%
RIVER				
Early Run				
ZHRC[a]	6,701	3,413	12 - 13,390	99.8%
NZHRC[b]	19,398	1,836	15,799 - 22,997	18.6%
Total	26,099	3,875	18,504 - 33,694	29.1%
Late Run				
Weekdays	28,844	4,821	19,396 - 38,292	32.8%
Weekends	17,975	4,093	9,953 - 25,997	44.6%
Total	46,819	6,324	34,425 - 59,213	26.5%
Total	72,918	7,417	58,381 - 87,455	19.9%
GRAND TOTAL	233,215	13,151	207,439 - 258,991	11.1%

[a] Zero harvest rate component. The temporal segment of the early run fishery from 6/12 through 6/22, when angler harvest rates were zero prior to the movement of fish from the confluence area into the Russian River.

[b] Non-zero harvest rate component. The temporal segment of the early run fishery from 6/23 through 6/30 during which fish were

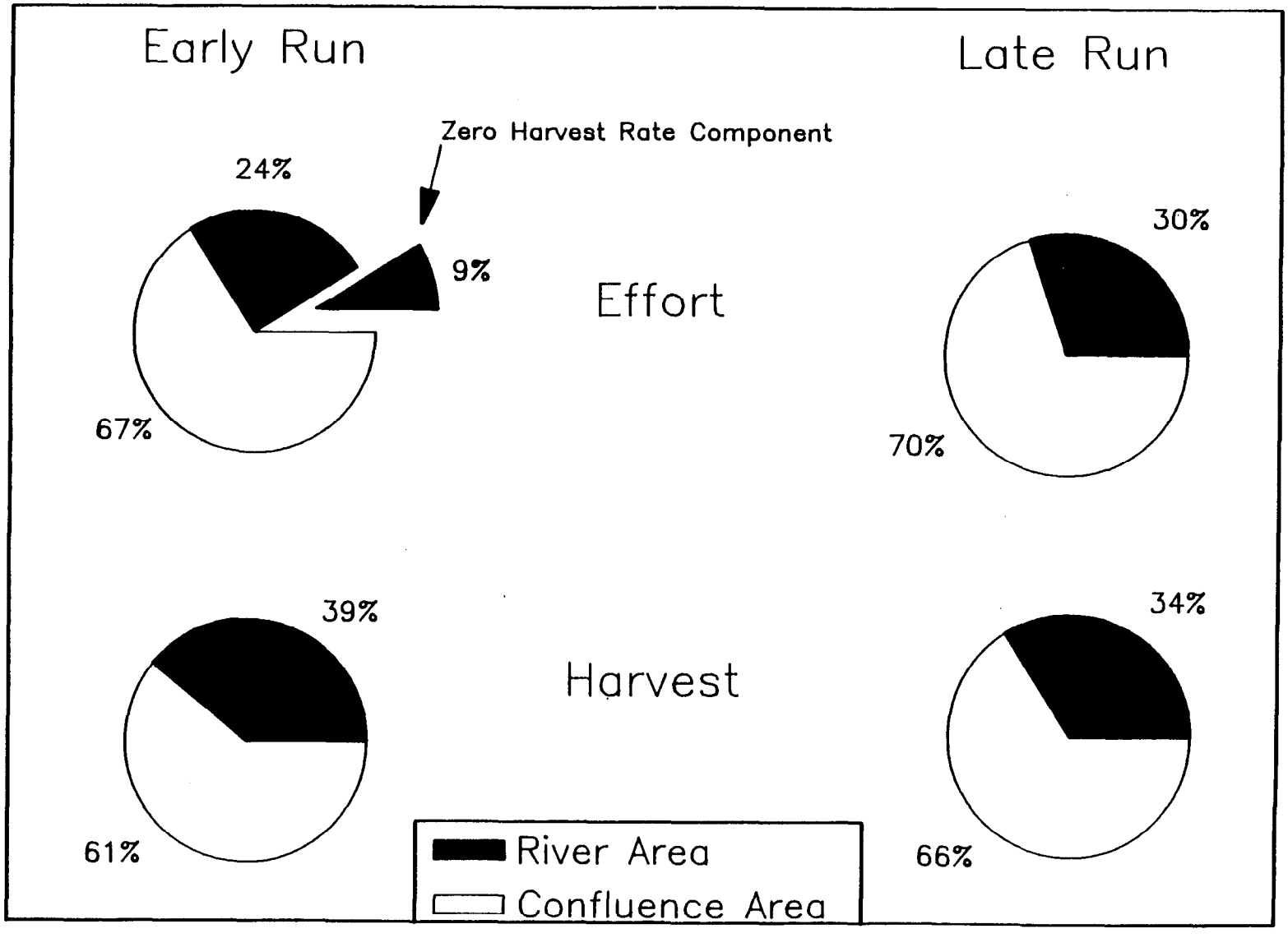

Figure 5. Harvest and angler effort by area in the Russian River recreational sockeye salmon fishery, 1989.

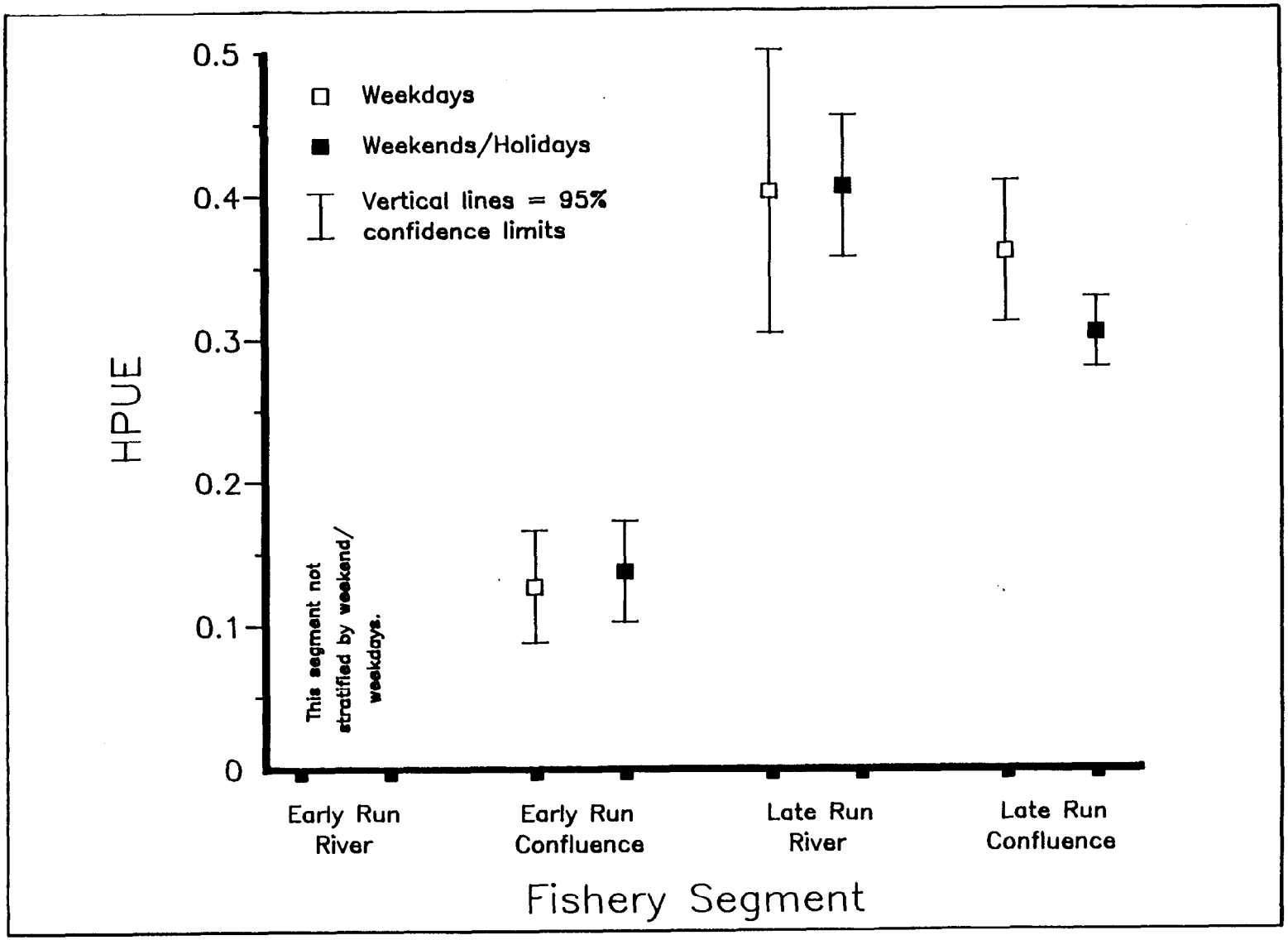

Figure 6. Weekday and weekend/holiday HPUE by location and seasonal components in the Russian River recreational fishery, 1989.

Table 3. Estimated harvest per unit effort (HPUE) of sockeye salmon by anglers interviewed during each component of the Russian River fishery, 1989.

Stratum	Days n[a]	Days N[b]	Number of Interviews	HPUE	Standard Error
CONFLUENCE					
Early Run					
Weekdays	10	15	252	0.1255	0.0179
Weekends	6	6	306	0.1439	0.0140
Late Run					
Weekdays	12	25	504	0.3611	0.0288
Weekends	10	10	568	0.3015	0.0143
RIVER					
Early Run					
ZHRC[c]	4	11	29	0.0000	0.0000
NZHRC[d]	8	8	197	0.2244	0.0332
Late Run					
Weekdays	13	25	224	0.4060	0.0507
Weekends	10	10	252	0.4077	0.0251

[a] Number of days on which interviews were conducted.

[b] Number of days possible for conducting interviews.

[c] Zero harvest rate component. The temporal segment of the early run fishery from 6/12 through 6/22, when angler harvest rates were zero prior to the movement of fish from the confluence area into the Russian River.

[d] Non-zero harvest rate component. The temporal segment of the early run fishery from 6/23 through 6/30 during which fish were present in the Russian River and angler harvest rates were non-zero.

Table 4. Estimated number of sockeye salmon harvested during each component of the Russian River fishery, 1989.

Stratum	Estimated Harvest	Standard Error	95% Confidence Interval	Relative Precision
CONFLUENCE				
Early Run				
Weekdays	4,353	772	5,336 - 8,528	34.7%
Weekends	2,579	259	2,071 - 3,087	19.7%
Total	6,932	814	5,336 - 8,528	23.0%
Late Run				
Weekdays	22,422	3,248	16,056 - 28,788	28.4%
Weekends	13,749	2,171	9,494 - 18,004	30.9%
Total	36,171	3,907	28,514 - 43,828	21.2%
Both Runs				
Weekdays	26,775	3,338	20,233 - 33,317	24.4%
Weekends	16,328	2,186	12,043 - 20,613	26.2%
Total	43,103	3,990	35,283 - 50,923	18.1%
RIVER				
Early Run				
ZHRC[a]	0	0		
NZHRC[b]	4,353	576	3,224 - 5,482	25.9%
Total	4,353	576	3,224 - 5,482	25.9%
Late Run				
Weekdays	11,711	2,430	6,947 - 16,475	40.7%
Weekends	7,328	1,725	3,946 - 10,710	46.1%
Total	19,039	2,981	13,197 - 24,881	30.7%
Both Runs				
Total	23,392	3,036	17,441 - 29,343	25.4%
GRAND TOTAL	66,495	5,014	56,668 - 76,322	14.8%

[a] Zero harvest rate component. The temporal segment of the early run fishery from 6/12 through 6/22, when angler harvest rates were zero prior to the movement of fish from the confluence area into the Russian River.

[b] Non-zero harvest rate component. The temporal segment of the early run fishery from 6/23 through 6/30 during which fish were present in the Russian River and angler harvest rates were non-zero.

Table 5. Summary of estimated angler-effort and harvest of sockeye salmon by run for each area of the Russian River fishery, 1989.

Component	Confluence Area	River Area	Total	95% Confidence Interval
EARLY RUN				
Effort	52,603	26,099	78,702	68,167 - 89,237
Standard Error	3,725	3,876	5,375	
Harvest	6,932	4,353	11,285	9,331 - 13,239
Standard Error	814	576	997	
LATE RUN				
Effort	107,694	46,819	154,513	130,989 - 178,037
Standard Error	10,201	6,324	12,002	
Harvest	36,171	19,039	55,210	45,579 - 64,841
Standard Error	3,907	2,981	4,914	
TOTAL BOTH RUNS				
Effort	160,297	72,918	233,215	207,439 - 258,991
Standard Error	10,860	7,417	13,151	
Harvest	43,103	23,392	66,495	56,667 - 76,323
Standard Error	3,991	3,036	5,015	

Spawning Escapement

The escapements of early and late run sockeye salmon enumerated through the weir were 15,338 and 138,318 fish, respectively (Appendix A7 and Table 6). Transition between the two runs occurred between July 16 and July 20 (Figure 7). Weir enumeration ceased on September 12 and the weir was removed on September 13. While the sockeye salmon migration was virtually complete by this time, the coho salmon migration was still in progress and the count of coho salmon was therefore incomplete.

Both the early and late run escapements through the weir were comprised of five age groups: 2.3, 1.3, 2.2, 1.2, and 2.1. The predominant age group (67.3%) of the early run was 2.3 (Table 7). Age composition by sex did not significantly vary over time ($\chi^2_{females}$=4.81, df=2, P>0.05; $v2_{males}$=0.06, df=2, P>0.05). The predominant age group (62.7%) of the late run was 2.2 (Table 8), and although significant temporal changes in the age composition of females were not detected, there were significant temporal changes for the males (χ^2 males=26.85, df=4, P<0.05). During the first temporal stratum of the late run, age 2.1 males comprised a lesser proportion of the total male escapement than during the later two strata. Virtually all females were age 2.2. Three-ocean fish contributed 1.8% to the total late run escapement while 1-ocean males contributed 34.1%.

Based on data from past years (McBride and Athons 1987), it was assumed the early run harvest was not selective among age groups and therefore the age composition of the early run harvest was assumed to be similar to that of the escapement. Because there was no temporal change in age composition of the early run escapement as measured by analysis of samples taken at the weir, the samples were combined to estimate the age composition of the early run harvest. The late run harvest in the confluence area was composed of two major age groups: 2.2 (72.6%) and 2.3 (17.3%) (Table 9).

Length at age increased with duration of ocean residency and males were larger at each age for which there were comparable samples from each sex (Table 10).

The escapements of both runs through the weir, the estimated early run and late run harvests, and the estimated escapement downstream from the falls were apportioned by age group (Tables 11 and 12). While both brood years 1983 and 1984 were significant contributors to the early run return, age 2.3 fish returning from the 1983 brood year contributed the predominant proportion (67.3%). Brood years 1983, 1984, and 1985 contributed 0.9%, 63.7%, and 35.5% to the late run escapement past the weir, respectively. The 1984 brood year composed 78.6% of the escapement downstream from the falls and 78.3% of the late run harvest.

DISCUSSION

The 1989 early run return to the Russian River was 36% below the historical average and the recreational harvest was 44% below average. Based on analysis of recruit per spawner data from recent years, the early run minimum

Table 6. Escapements of sockeye, coho, and chinook salmon in the Russian River, 1989.

Component	Dates	Sockeye Salmon	Coho Salmon	Chinook Salmon
Early Run	06/18 - 07/20	15,338[a]		
Late Run	07/16 - 09/12	138,318[a]	1,122[b]	173
Downstream[c]	08/20	28,480[d]		70[e]

[a] From 7/16 through 7/20, early run fish were differentiated from late run fish based on the degree of external maturation (color).

[b] Only a partial count as the weir was removed prior to completion of migration.

[c] Fish that spawned downstream from the Russian River weir.

[d] 24,100 live fish, 4,380 dead fish that spawned downstream from the Russian River Falls.

[e] 6 live fish and 26 dead fish enumerated downstream from Russian River Falls, and 38 live fish enumerated upstream from the falls.

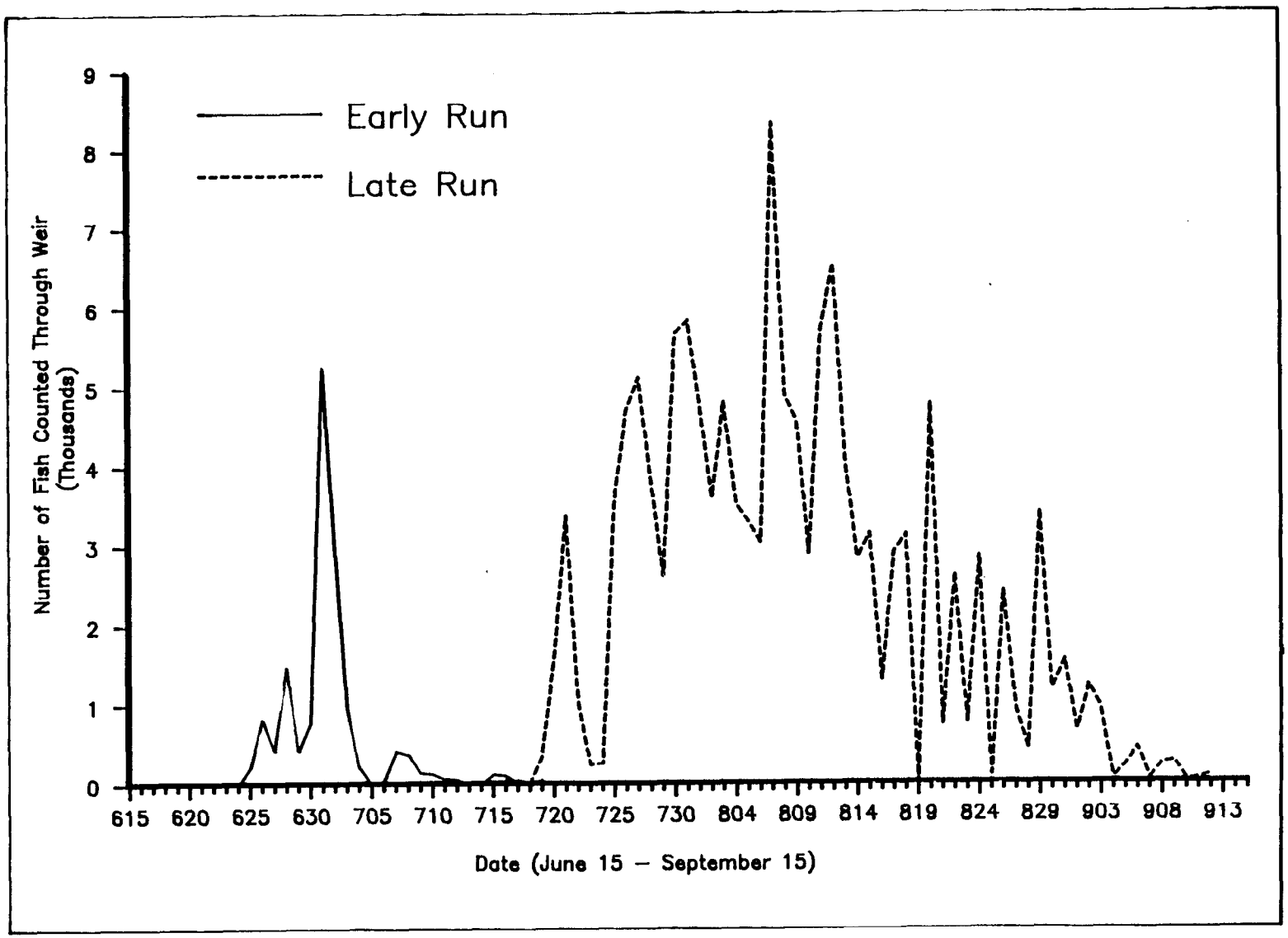

Figure 7. Daily escapement of sockeye salmon past Russian River Weir, 1989.

Table 7. Estimated age and sex composition of the early run, sockeye salmon escapement through the Russian River weir, 1989.

Dates	Age Group					
	2.3	1.3	2.2	1.2	2.1	Total
6/18 - 7/02 (n^a = 141)						
Females						
Percent	36.2	11.3	7.1	0.0	0.0	54.6
Number	3,456	1,079	678	0	0	5,213
Standard Error	388	255	207			
Males						
Percent	32.6	5.7	5.7	1.4	0.0	45.4
Number	3,112	544	544	134	0	4,334
Standard Error	378	187	187	95		
Sexes Combined						
Percent	68.8	17.0	12.8	1.4	0.0	100.0
Number	6,568	1,623	1,222	134	0	9,547
Standard Error	374	303	270	95		
7/03 - 7/20 (n^a = 114)						
Females						
Percent	36.7	8.8	16.7	0.0	0.0	62.2
Number	2,128	510	967	0	0	3,605
Standard Error	263	154	203			
Males						
Percent	28.1	4.4	5.3	0.0	0.0	37.8
Number	1,624	255	307	0	0	2,186
Standard Error	245	112	122			
Sexes Combined						
Percent	64.8	13.2	22.0	0.0	0.0	100.0
Number	3,752	765	1,274	0	0	5,791
Standard Error	260	184	226			

-Continued-

Table 7. (page 2 of 2)

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Early Run Total						
Females						
Percent	36.4	10.4	10.7	0.0	0	57.5
Number	5,584	1,589	1,645	0	0.0	8,818
Standard Error	463	294	297			
Males						
Percent	30.9	5.2	5.5	0.9	0	42.5
Number	4,736	799	851	134	0.0	6,520
Standard Error	445	214	219	91		
Sexes Combined						
Percent	67.3	15.6	16.2	0.9	0	100
Number	10,320	2,388	2,496	134	0.0	15,338
Standard Error	451	349	355	91		

[a] n = sample size.

Table 8. Estimated age and sex composition of the late run sockeye salmon escapement through the Russian River weir, 1989.

Dates	Age Group					
	2.3	1.3	2.2	1.2	2.1	Total
7/16 - 8/09 (n^a = 127)						
Females						
Percent	0.0	0.0	59.8	1.6	0.0	61.4
Number	0	0	47,417	1,269	0	48,686
Standard Error			3,463	886		
Males						
Percent	1.6	1.6	17.3	0.0	18.1	38.6
Number	1,269	1,269	13,718	0	14,351	30,607
Standard Error	886	886	2,672		2,720	
Sexes Combined						
Percent	1.6	1.6	77.1	1.6	18.1	100.0
Number	1,269	1,269	61,135	1,269	14,351	79,293
Standard Error	886	886	2,968	886	2,720	
8/10 - 8/20 (n^a = 108)						
Females						
Percent	0.0	0.0	22.3	0.9	0.0	23.2
Number	0	0	8,354	337	0	8,691
Standard Error			1,508	342		
Males						
Percent	0.0	0.0	12.0	0.9	63.9	76.8
Number	0	0	4,495	337	23,939	28,771
Standard Error			1,117	342	1,739	
Sexes Combined						
Percent	0.0	0.0	34.3	1.8	63.9	100.0
Number	0	0	12,849	674	23,939	37,462
Standard Error			1,719	481	1,739	

-Continued-

Table 8. (page 2 of 2)

Dates	Age Group					
	2.3	1.3	2.2	1.2	2.1	Total
8/21 - 9/12 (n[a] = 107)						
Females						
Percent	0.0	0.0	43.0	0.0	0.0	43.0
Number	0	0	9,272	0	0	9,272
Standard Error			1,037			
Males						
Percent	0.0	0.0	15.9	0.0	41.1	57.0
Number	0	0	3,429	0	8,862	12,291
Standard Error			766		1,030	
Sexes Combined						
Percent	0.0	0.0	58.9	0.0	41.1	100.0
Number	0	0	12,701	0	8,862	21,563
Standard Error			1,030		1,030	
Late Run Total						
Females						
Percent	0.0	0.0	47.1	1.2	0.0	48.3
Number	0	0	65,043	1,606	0	66,649
Standard Error			3,739	816		
Males						
Percent	0.9	0.9	15.6	0.2	34.1	51.7
Number	1,269	1,269	21,642	337	47,152	71,669
Standard Error	707	707	2,718	335	3,551	
Sexes Combined						
Percent	0.9	0.9	62.7	1.4	34.1	100.0
Number	1,269	1,269	86,685	1,943	47,152	138,318
Standard Error	707	707	3,622	880	3,551	

[a] n = sample size.

Table 9. Estimated age and sex composition of sockeye salmon harvested during the Russian River recreational fishery, 1989.

Component	Age Group					
	2.3	1.3	2.2	1.2	2.1	Total
Early Run[a] (n^b = 255)						
Females						
Percent	36.4	10.4	10.7	0.0	0.0	57.5
Number	4,108	1,174	1,206	0	0	6,488
Standard Error	497	239	243			
Males						
Percent	30.9	5.2	5.5	0.9	0.0	42.5
Number	3,487	587	621	102	0	4,797
Standard Error	448	165	170	67		
Sexes Combined						
Percent	67.3	15.6	16.2	0.9	0.0	100.0
Number	7,595	1,761	1,827	102	0	11,285
Standard Error	748	299	306	67	0	
Late Run[c] (n^b = 366)						
Females						
Percent	6.6	3.0	44.2	1.4	0.0	55.2
Number	3,644	1,656	24,402	773	0	30,475
Standard Error	785	513	2,600	345		
Males						
Percent	10.7	2.7	28.4	0.8	2.2	48.7
Number	5,907	1,491	15,680	442	1,215	24,735
Standard Error	1,033	485	1,906	259	436	
Sexes Combined						
Percent	17.3	5.7	72.6	2.2	2.2	100.0
Number	9,551	3,147	40,082	1,215	1,215	55,210
Standard Error	1,381	724	3,792	436	436	

[a] Assumes the age/sex composition of the harvest is similar to the escapement.

[b] n = sample number.

[c] Assumes the age/sex composition of the harvest at the confluence area is representative of the total late run harvest.

Table 10. Mean length (millimeters) at age by sex of sockeye salmon sampled from the Russian River, 1989.

Component		Age Class				
		2.3	1.3	2.2	1.2	2.1
Early Run Escapement[a]						
Female	Mean Length	611	602	545		
	Standard Error	2.3	4.8	6.4		
	Sample Size	93	26	29		
Male	Mean Length	614	612	560	570	
	Standard Error	2.3	6.5	8.4	5.0	
	Sample Size	78	13	14	2	
Late Run Escapement[a]						
Female	Mean Length			516	533	
	Standard Error			2.4	12.0	
	Sample Size			146	3	
Male	Mean Length	625	675	525		403
	Standard Error	15.0	5.0	5.2		3.4
	Sample Size	2	2	52		136
Downstream Escapement[b]						
Female	Mean Length	581	568	527	557	
	Standard Error	8.3	4.5	38.4	5.2	
	Sample Size	4	50	3	7	
Male	Mean Length	615	603	545	588	
	Standard Error	12.8	4.9	10.0	10.6	
	Sample Size	4	48	2	13	
Confluence Harvest[c]						
Female	Mean Length	581	585	536	562	
	Standard Error	6.4	6.0	2.0	17.3	
	Sample Size	24	11	162	5	
Male	Mean Length	611	616	541	527	438
	Standard Error	3.6	5.4	3.8	23.3	26.9
	Sample Size	39	10	104	3	8

[a] Fish that migrated through the weir.
[b] Late run fish that spawned downstream from Russian River Falls.
[c] Late run only.

Table 11. Estimated age composition and numbers by age group in the harvest and escapement of sockeye salmon in the Russian River, 1989.

Brood Year	1983	1984		1985		
Age Group	2.3	1.3	2.2	1.2	2.1	Total
ESCAPEMENT						
Early Run[a]						
Percent	67.3	15.6	16.2	0.9	0	100.0
Number	10,320	2,388	2,496	134	0.0	15,338
Late Run[a]						
Percent	0.9	0.9	62.7	1.4	34.1	100.0
Number	1,269	1,269	86,685	1,943	47,152	138,318
Downstream[b]						
Percent	6.2	74.8	3.8	15.2	0.0	100.0
Number	1,766	21,303	1,082	4,329	0	28,480[c]
HARVEST						
Early Run[d]						
Percent	67.3	15.6	16.2	0.9	0	100.0
Number	7,595	1,761	1,827	102	0.0	11,285
Late Run						
Percent	17.3	5.7	72.6	2.2	2.2	100.0
Number	9,551	3,147	40,082	1,215	1,215	55,210

[a] Fish that passed through the weir.

[b] Fish that spawned downstream from Russian River Falls.

[c] Peak count from foot survey.

[d] Assumes age/sex composition of the recreational harvest is similar to the escapement.

Table 12. Estimated age and sex composition of sockeye salmon which spawned downstream from the Russian River Falls, 1989.

	Age Group					
	2.3	1.3	2.2	1.2	2.1	Total
(n[a] = 131)						
Females						
Percent	3.1	38.2	2.3	5.3	0.0	48.9
Number	883	10,879	655	1,509	0	13,926
Standard Error	433	1,214	374	560		
Males						
Percent	3.1	36.6	1.5	9.9	0.0	51.1
Number	883	10,424	427	2,820	0	14,554
Standard Error	433	1,203	304	746		
Sexes Combined						
Percent	6.2	74.8	3.8	15.2	0.0	100.0
Number	1,766	21,303	1,082	4,329	0	28,480
Standard Error	602	1,084	478	897		

[a] n = sample size.

escapement goal for the 1989 return was increased from 9,000 to 20,000. In-season information which included low weir counts, low harvest rates in the confluence segment of the sport fishery, high harvest rates in the river segment of the sport fishery, and low numbers of fish visually enumerated in the Russian River and the confluence area (primarily in the sanctuary), forced a fishery closure on July 1 in an effort to achieve the new escapement goal. The early run escapement was completely enumerated (15,338) at the weir by July 20 and the new escapement goal was not met.

The effort estimate generated by the creel survey requires at least two angler counts per period in each stratum (weekdays and weekend/holidays) to generate effort and harvest estimates by period with measures of relative precision. The early closure of the early run fishery precluded such estimates for the non-zero harvest rate component of the river segment fishery and estimates were made by weekly period.

The method used for estimation of harvest in the Russian River creel survey assumes proportional sampling of each fishery stratum. However, examination of the number of interviews relative to the total angler hours estimated for each stratum shows that this assumption may not have been met in the 1989 survey (Figure 8). A larger proportion of anglers was interviewed on weekends compared to weekdays in all strata of the survey. To determine if assumption of independence between total effort and angler success was met, the relationship between HPUE and mean angler counts within strata was examined (Figure 9). Over all fishery components, the assumption of independence was not met because higher mean angler counts corresponded to greater HPUE values.

The suitability of an alternative creel survey sample design should be examined with emphasis on designs that obviate the assumptions of proportional sampling and independence of effort and harvest rates. Because no significant difference could be found in HPUE between weekend and weekday strata within a location and seasonal component (Figure 6, Table 3), eliminating stratification by day type (weekdays, weekends) should be considered. A suitable design will be implemented in 1990.

Angler effort (78,702 angler-hours) expended during the early run was 18% below the historical average (Nelson 1990), but may have been artificially low due to the closure of the early run fishery. The mean early run HPUE of 0.143 was 15% below the historical average.

The magnitude of the 1989 late run return (193,528) was second only to that of 1985 (Nelson 1990). The 1989 sport harvest was also second only to that of the 1985 sport harvest, while the 1989 spawning escapement was a record (138,318).

Angler effort (154,513 angler-hours) expended during the late run was 116% greater than the historical mean effort and the HPUE was 50% greater than the historical mean.

In the past, it has been assumed that the age composition of the late run sport harvest in the confluence area is representative of the age composition

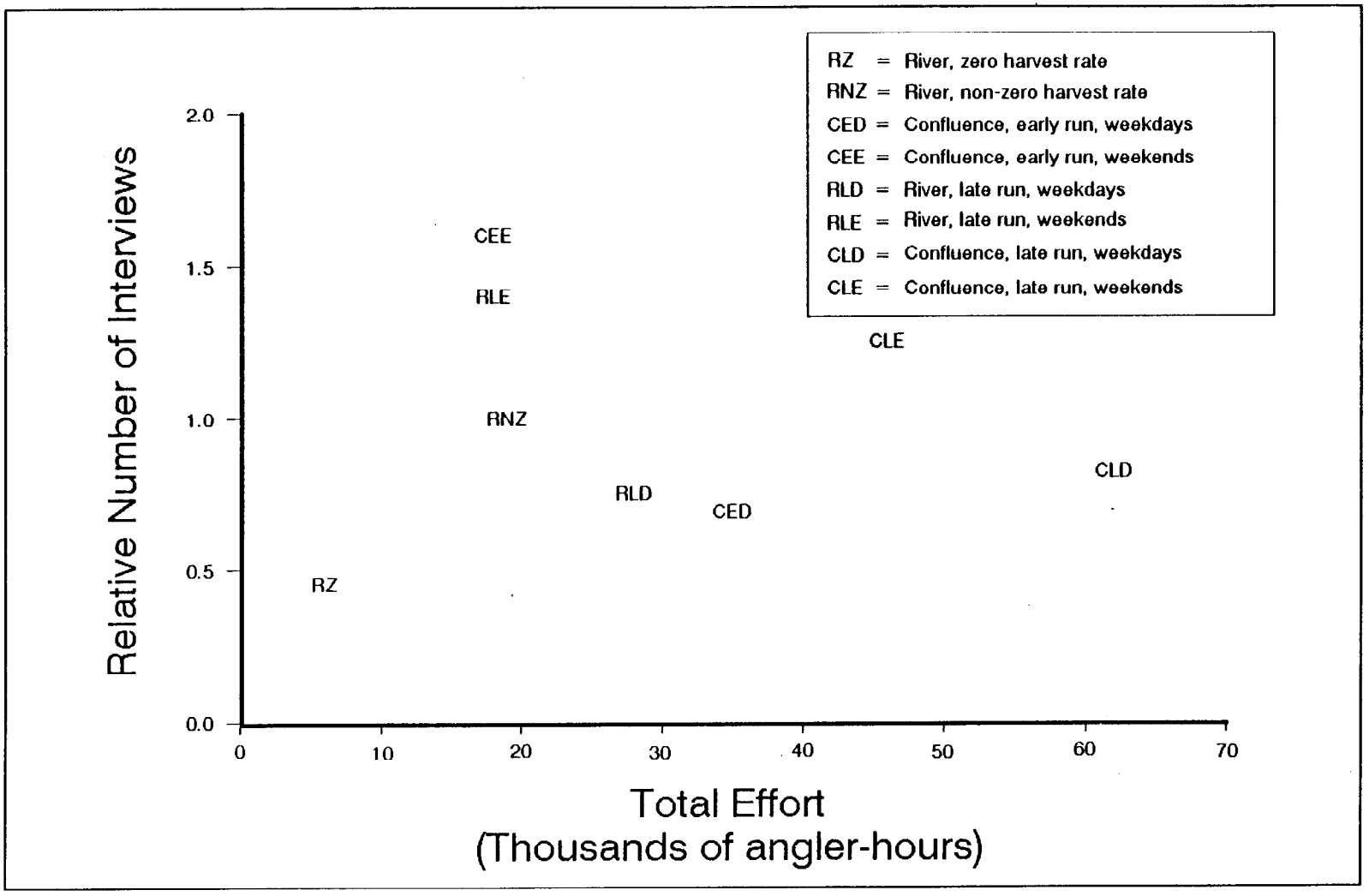

Figure 8. Comparison of relative number of interviews with total effort by stratum and fishery component in the Russian River recreational sockeye salmon fishery, 1989 (relative number of interviews).

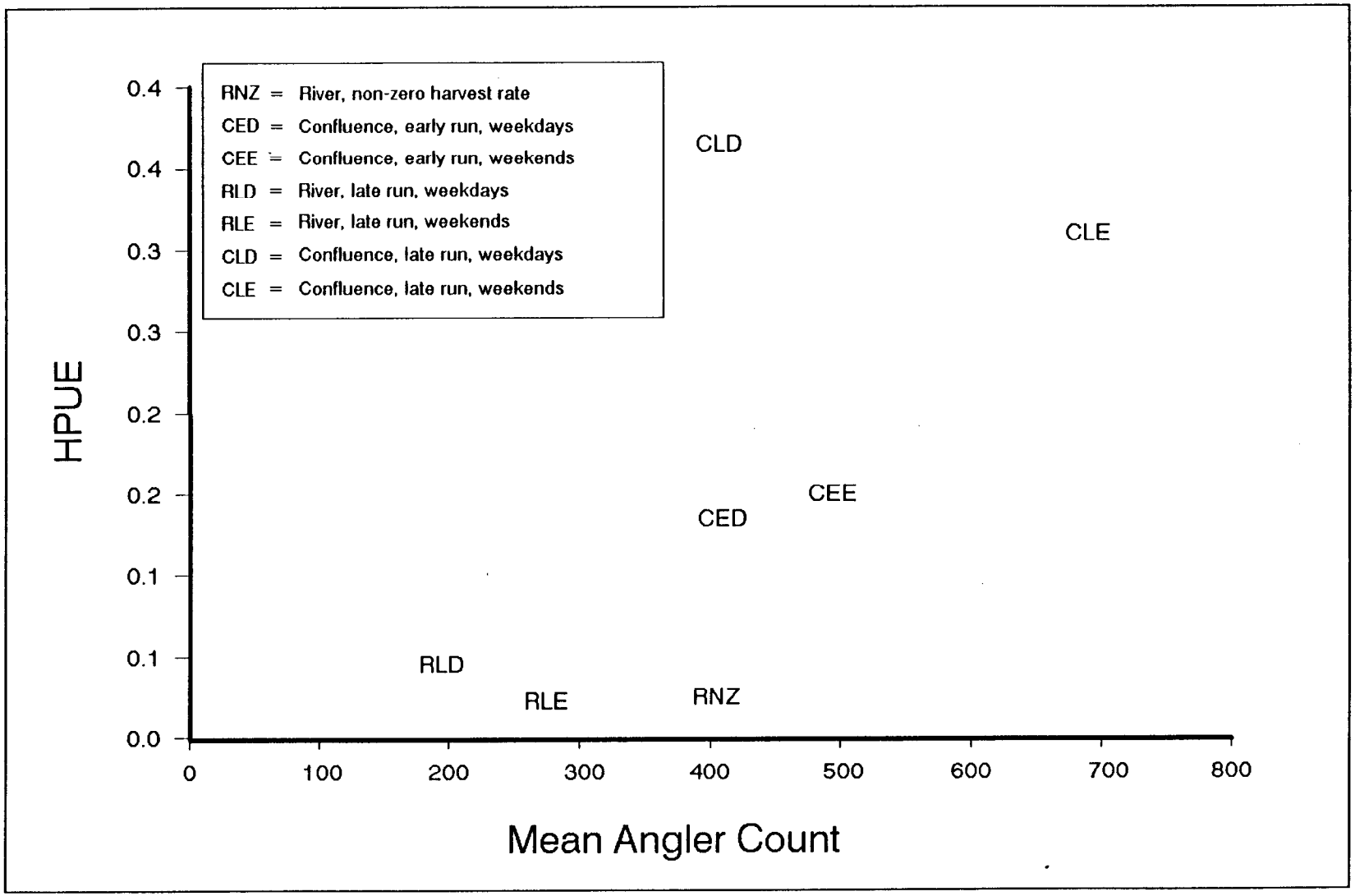

Figure 9. Relationship of angler success (HPUE) and angler effort (mean angler count) within strata in the Russian River recreational sockeye salmon fishery, 1989.

of the late run river area harvest, and the entire late run sport harvest (confluence area and river area) has been apportioned by applying age composition estimates based on samples taken exclusively from the confluence area. However, staff observations also indicate that fish in advanced stages of maturation are released upon being captured from the river area by anglers desiring "bright" fish (Hammarstrom and Athons 1989). Typically, the more mature fish appear in the river area during the first week in August and are primarily age 1.3. These fish spawn downstream from the Russian River falls and intermingle with less mature fish that are destined for spawning grounds upstream of the falls. Depending on the timing of the arrival of this population of mature fish at the confluence area and the degree of maturation at the time of arrival, anglers fishing at the confluence may harvest these fish in proportion to their numbers relative to other ages if the anglers find the fish to be in acceptable condition.

The sockeye salmon passing through the confluence fishery are comprised of fish bound for the Russian River as well as fish bound for spawning areas in the mainstem Kenai River. Because the Kenai River fish comprise an unknown proportion of the confluence harvest, and because anglers may select against age 1.3 fish in the river fishery but not in the confluence fishery, the age composition of the harvest from the confluence area may not be representative of the harvest from the river area, which comprised 34% of the late run harvest in 1989 (Figure 5). Therefore, to more accurately estimate the age composition of the river area component of the late run harvest, it is recommended that the river area harvest be sampled separately in 1990.

Angler effort began to decline in the confluence and river areas 2 weeks prior to the close of the late run fishery on August 20 (Figure 3). During this time, catch rates remained high and large numbers of fish were still present in the fishery (Figure 4). In fact, only 42% of the late run escapement had been passed through the weir by August 5 (Figure 6). The near record late run harvest coupled with a record sport harvest of sockeye salmon in the mainstem Kenai River in 1989 (Nelson 1990) may have satisfied peak angler demand relatively early in the run.

ACKNOWLEDGEMENTS

Deric Marcorelle assisted with initiation of field operations for the 1989 season. He also operated the Russian River weir, collected creel survey data and age, sex, and length data, and assisted with post-season scale aging and report preparation. Paul Zallek collected creel survey data and age, sex, and length data from the fishery and monitored the fishery for regulation violations. Stephanie King, Bob Begich, and Terri Edmundson provided weir operation relief. Dave Athons and Dave Nelson have extensive experience with this project and provided invaluable programmatic recommendations as well as logistical support. Larry Marsh provided the technical support necessary to utilize field data recording equipment. Doug McBride provided valuable guidance in achieving project objectives.

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APPENDIX A

Appendix A1. Angler counts in the Russian River early run sockeye salmon fishery, 1989.

Date	Wd/We[b]	River Fishery Period[a] A	River Fishery Period[a] B	River Fishery Period[a] C	Confluence Fishery Period A	Confluence Fishery Period B	Confluence Fishery Period C
6/10	We			0	64		27
6/11	We	0			69	63	
6/12	Wd		1			56	
6/13	Wd						
6/14	Wd						
6/15	Wd						
6/16	Wd		26			122	
6/17	We			12		304	301
6/18	We		8			173	143
6/19	Wd			26		258	213
6/20	Wd						
6/21	Wd						
6/22	Wd			119	176		213
6/23	Wd		130		106	204	
6/24	We	73			222	235	
6/25	We		148		193	197	
6/26	Wd	115			144	98	
6/27	Wd				123	135	
6/28	Wd					127	
6/29	Wd	158	163		64		74
6/30	Wd				46		

[a] Period A: 0600 - 1159.
Period B: 1200 - 1759.
Period C: 1800 - 2359.

[b] Weekday (Wd) or Weekend (We).

Appendix A2. Angler counts in the Russian River late run sockeye salmon fishery, 1989.

Date	Wd/We[b]	River Fishery Period[a] A	B	C	Confluence Fishery Period A	B	C
7/16	We		26			157	67
7/17	Wd		4			153	127
7/18	Wd			8	174		193
7/19	Wd			17	210		189
7/20	Wd						
7/21	Wd						
7/22	We			25		476	414
7/23	We		36			436	145
7/24	Wd	74	129		91	144	
7/25	Wd				51	271	
7/26	Wd						
7/27	Wd						
7/28	Wd	126			312		251
7/29	We	228			313		265
7/30	We	157			376		251
7/31	Wd			85	174		236
8/01	Wd			105		166	119
8/02	Wd						
8/03	Wd						
8/04	Wd		143			243	233
8/05	We		108		223	372	
8/06	We		198		104	305	
8/07	Wd	50			54		112
8/08	Wd		90	75			117
8/09	Wd		71		39	98	
8/10	Wd						
8/11	Wd						
8/12	We		120		19	164	
8/13	We	37		22			79
8/14	Wd	19	55		19		23
8/15	Wd	37	60		3	31	
8/16	Wd						
8/17	Wd						
8/18	Wd		55			24	
8/19	We		59	48		53	

[a] Period A: 0600 - 1159.
Period B: 1200 - 1759.
Period C: 1800 - 2359.

[b] Weekday (Wd) of Weekend (We).

Appendix A3. Daily summary statistics for fishing effort and sockeye salmon harvest in the river segment of the Russian River fly-fishing-only area during the early run, 1989.

Date	Wd/ We[a]	EFFORT (HRS) SS[b]	Mean	SE	HARVEST Mean	SE	HPUE
6/10	We	0[c]					
6/11	We	0[c]					
6/12	Wd	0[c]					
6/16	Wd	3	1.0	0.00	0.00	0.000	0.000
6/17	We	0[c]					
6/18	We	9	2.7	1.00	0.00	0.000	0.000
6/19	Wd	5	2.0	0.63	0.00	0.000	0.000
6/22	Wd	12	2.4	0.37	0.00	0.000	0.000
6/23	Wd	24	4.1	0.78	0.33	0.115	0.082
6/24	We	20	1.4	0.13	0.10	0.069	0.074
6/25	We	30	2.9	0.44	0.10	0.056	0.034
6/26	Wd	35	3.4	0.23	1.66	0.217	0.481
6/27	Wd	10	4.2	0.88	0.20	0.200	0.048
6/28	Wd	23	4.1	0.36	1.00	0.209	0.242
6/29	Wd	24	3.3	0.35	1.29	0.229	0.392
6/30	Wd	31	4.0	0.39	0.81	0.204	0.204

[a] Weekday (Wd) or Weekend (We).

[b] Sample size, number of anglers interviewed.

[c] Survey conducted, no anglers interviewed.

Appendix A4. Daily summary statistics for fishing effort and sockeye salmon harvest in the confluence segment of the Russian River fly-fishing-only area during the early run, 1989.

Date	Wd/ We[a]	EFFORT (HRS) SS[b]	Mean	SE	HARVEST Mean	SE	HPUE
6/10	We	14	2.6	0.27	0.21	0.114	0.083
6/11	We	67	3.8	0.28	0.25	0.086	0.067
6/12	Wd	20	4.8	0.49	0.80	0.258	0.168
6/16	Wd	21	3.6	0.27	0.57	0.235	0.160
6/17	We	50	4.9	0.34	0.48	0.132	0.098
6/18	We	64	4.5	0.23	1.17	0.154	0.262
6/19	Wd	44	4.0	0.30	0.70	0.144	0.175
6/22	Wd	15	3.5	0.27	0.60	0.235	0.173
6/23	Wd	9	6.3	1.17	1.11	0.423	0.175
6/24	We	87	4.4	0.25	0.43	0.079	0.097
6/25	We	24	4.6	0.55	1.38	0.268	0.299
6/26	Wd	35	4.9	0.36	0.34	0.136	0.070
6/27	Wd	32	4.9	0.37	0.56	0.179	0.115
6/28	Wd	48	3.9	0.35	0.35	0.117	0.091
6/29	Wd	26	3.0	0.48	0.27	0.089	0.090
6/30	Wd	2	1.5	0.00	0.00	0.000	0.000

[a] Weekday (Wd) or Weekend (We).

[b] Sample size, number of anglers interviewed.

Appendix A5. Daily summary statistics for fishing effort and sockeye salmon harvest in the river segment of the Russian River fly-fishing-only area during the late run, 1989.

Date	Wd/ We[a]	EFFORT (HRS) SS[b]	Mean	SE	HARVEST Mean	SE	HPUE
7/16	We	19	1.3	0.33	0.05	0.053	0.039
7/18	Wd	4	1.8	0.43	1.50	0.289	0.857
7/19	Wd	7	1.9	0.56	0.14	0.143	0.074
7/22	We	9	2.2	0.79	0.44	0.338	0.200
7/23	We	29	2.7	0.26	0.45	0.154	0.169
7/24	Wd	12	2.3	0.29	2.25	0.392	0.964
7/25	Wd	25	3.6	0.35	0.80	0.224	0.222
7/28	Wd	22	2.2	0.31	0.77	0.271	0.354
7/29	We	41	3.2	0.29	1.61	0.200	0.500
7/30	We	18	2.4	0.60	1.44	0.294	0.612
7/31	Wd	38	4.3	0.43	1.32	0.220	0.309
8/01	Wd	11	5.3	0.86	1.45	0.455	0.274
8/04	Wd	25	3.1	0.28	1.08	0.237	0.344
8/05	We	28	3.4	0.38	0.25	0.122	0.074
8/06	We	44	4.3	0.30	2.09	0.175	0.492
8/07	Wd	12	2.3	0.18	1.25	0.329	0.545
8/08	Wd	32	4.2	0.39	1.66	0.232	0.397
8/09	Wd	18	2.1	0.23	1.94	0.286	0.921
8/12	We	14	3.1	0.46	1.86	0.361	0.591
8/13	We	31	3.6	0.24	1.74	0.236	0.480
8/14	Wd	10	2.5	0.20	2.30	0.367	0.920
8/15	Wd	8	2.4	0.45	0.75	0.412	0.308
8/19	We	19	3.6	0.44	2.00	0.286	0.563

[a] Weekday (Wd) or Weekend (We).

[b] Sample size, number of anglers interviewed.

Appendix A6. Daily summary statistics for fishing effort and sockeye salmon harvest in the confluence segment of the Russian River fly-fishing-only area during the late run, 1989.

Date	Wd/ We[a]	EFFORT (HRS) SS[b]	Mean	SE	HARVEST Mean	SE	HPUE
7/16	We	52	4.5	0.31	0.88	0.166	0.196
7/17	Wd	67	4.1	0.32	0.90	0.126	0.219
7/18	Wd	67	3.8	0.18	1.00	0.149	0.261
7/19	Wd	56	3.3	0.31	1.09	0.168	0.328
7/22	We	126	5.0	0.21	1.24	0.108	0.248
7/23	We	105	5.0	0.25	1.01	0.107	0.201
7/24	Wd	47	4.9	0.30	1.49	0.187	0.302
7/25	Wd	20	3.0	0.43	1.40	0.303	0.459
7/28	Wd	43	3.2	0.27	2.26	0.176	0.705
7/29	We	83	3.9	0.24	2.08	0.124	0.529
7/30	We	54	4.7	0.27	1.39	0.153	0.298
7/31	Wd	42	4.3	0.33	1.98	0.182	0.465
8/01	Wd	49	4.8	0.23	2.08	0.142	0.433
8/04	Wd	50	4.1	0.32	1.52	0.190	0.370
8/05	We	57	3.7	0.23	1.37	0.171	0.369
8/06	We	24	4.6	0.80	2.25	0.219	0.491
8/07	Wd	35	4.7	0.27	1.43	0.160	0.306
8/08	Wd	16	5.3	0.48	1.94	0.266	0.369
8/09	Wd	12	2.4	0.24	1.08	0.379	0.448
8/12	We	22	4.8	0.34	1.18	0.215	0.248
8/13	We	30	4.9	0.40	1.40	0.270	0.288
8/19	We	15	4.8	0.45	2.13	0.307	0.448

[a] Weekday (Wd) or Weekend (We).

[b] Sample size, number of anglers interviewed.

Appendix A7. Daily escapement of sockeye, coho, and chinook salmon through the Russian River weir, 1989.

Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
6/18	4			
6/19	0			
6/20	33			
6/21	0			
6/22	33			
6/23	14			
6/24	0			
6/25	0			
6/26	226			
6/27	832			
6/28	428			
6/29	1,494			
6/30	424			
7/01	784			
7/02	5,275			
7/03	3,017			
7/04	981			
7/05	219			
7/06	0			
7/07	46			
7/08	432			
7/09	380			
7/10	141			1
7/11	125			0
7/12	66			0
7/13	63			0
7/14	0			0
7/15	0			0
7/16	125	54		0
7/17	104	43		0
7/18	27	21		1
7/19	12	365		0
7/20	53	1,592		1
7/21		3,395		2
7/22		1,040		1
7/23		246		0
7/24		267		0
7/25		3,565		8

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Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
7/26		4,711		4
7/27		5,133		4
7/28		3,830		0
7/29		2,621		6
7/30		5,683		11
7/31		5,845		0
8/01		4,788		4
8/02		3,606		0
8/03		4,825		1
8/04		3,514		2
8/05		3,302		5
8/06		3,043		7
8/07		8,351		12
8/08		4,889		3
8/09		4,564		11
8/10		2,901		6
8/11		5,749		10
8/12		6,555		13
8/13		4,057		9
8/14		2,849	4	8
8/15		3,157	7	4
8/16		1,314	3	1
8/17		2,927	10	2
8/18		3,147	18	15
8/19		0	0	0
8/20		4,806	17	7
8/21		741	2	1
8/22		2,650	6	3
8/23		778	0	1
8/24		2,877	11	2
8/25		104	0	0
8/26		2,436	11	0
8/27		924	6	4
8/28		447	0	0
8/29		3,436	37	2
8/30		1,189	6	1
8/31		1,564	30	0
9/01		675	24	0
9/02		1,244	31	0
9/03		944	18	0
9/04		64	12	0
9/05		239	78	0

-Continued-

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Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
9/06		456	193	0
9/07		60	18	0
9/08		251	183	0
9/09		280	162	0
9/10		38	43	0
9/11		60	75	0
9/12		106	117	0
Totals	15,338	138,318	1,122	173

[a] From 7/16 through 7/20, early run fish were differentiated from late run fish based on degree of external maturation.